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PROPOSED HARVESTING GUIDES BASED UPON AN ENVIRONMENTAL CLASSIFICATION IN THE SOUTH UMPQUA BASIN OF OREGON

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ABSTRACT

Success or failure of forest regeneration on clearcuts is significantly related to soil depth and texture, elevation, solar radiation, moisture, and temperature of the preharvest environment. Regression equations express these relationships. They should be useful in comparing potential regeneration difficulty on areas to be harvested.

Keywords: Management planning (- regeneration), clearcutting systems.

INTRODUCTION

Clearcutting forest stands in parts of southwestern Oregon exposes the site to environmental extremes--frost, heat, drought--that limit establishment of regeneration. Tree seedlings may be established on such sites by leaving an overstory of mature trees to protect the site during the regeneration period (Franklin and DeBell 1973, Minore 1973, Williamson 1973). Unfortunately, problem sites are difficult to identify before harvesting.

The study reported here is part of a continuing research program aimed at improving forest regeneration in southwestern Oregon. The approach utilizes a proposed environmental classification in the South Umpqua basin (Minore 1972). In that proposal environments were classified using indices based on elevation, temperature, moisture, solar radiation, and soil type. In this paper we have related success or failure of regeneration on clearcuts to the apparent preharvest environment. Some significant relationships were found. It appears possible, therefore, to classify the preharvest environment and, based on this classification, make at least a rough prediction of regeneration success after clearcutting.

METHODS

The study area is the portion of the South Umpqua basin above Canyonville, Oregon. It is bounded on the west by North Myrtle, Canyon, and Starveout Creeks, on the south and east by the South Umpqua - Rogue divide, and on the north by the South Umpqua - Little River divide (fig. 1). Every clearcut logged before 1969 on Bureau of Land Management and Umpqua National Forest lands within this area was examined on aerial photographs or in the field to find situations where all or part of a clearcut

Figure 1. The study area.

area and an adjacent uncut stand were located on the same slope, aspect, and soil series. We assumed the environment under the uncut stand was the same as the preharvest environment on the matching clearcut area. This permitted effective use of native plants under the uncut stand as indicators of moisture and temperature. Actually, most plant species survive logging and slash burning and are present on clearcuts, but they become scattered and difficult to classify (Dyrness 1973). In studying eligible clearcut areas and adjacent stands, we made the following assumptions:

a. Environmental factors strongly influence the success or failure of forest regeneration after clearcutting.
b. Three or more years after harvesting, differences in clearcut stocking result from environmental differences between areas.
c. Vegetation now present in the uncut stand was present in the clearcut area before logging.
d. The best available reforestation techniques were used on the clearcut areas sampled. (As all sample clearcuts were at least 3 years old in 1972, these techniques were the ones commonly used before 1969).

Most clearcut boundaries coincided with topographic discontinuities, and only about 10 percent of the clearcuts within our study area contained areas with the same slopes, aspects, and soil series as adjacent uncut stands. The number of eligible clearcuts was further reduced by our restricting the sample to those logged before 1969. This allowed at least 3 years for planted stock and natural regeneration to become established on areas where environmental factors and regeneration were compared. The 57 areas that met all sampling criteria were selected without any attempt to stratify by slope, aspect, soil series, age, or location within the study area and were harvested between 1950 and 1968 (table 1). Of the selected clearcuts, 47 (83 percent) were planted at least once after harvesting, 15 (26 percent) were seeded as well, 6 (10 percent) were seeded without planting, and 4 (7 percent) were left for natural regeneration.

The following were measured on each clearcut area:

a. Elevation determined with an altimeter calibrated against known benchmarks.
b. Slope in percent.
c. Aspect.

Table 1.--*Age distribution of sampled clearcuts*

Year of harvest	Number of clearcuts	Year of harvest	Number of clearcuts
1950	1	1960	2
1951	1	1961	1
1952	4	1962	3
1954	3	1963	3
1955	3	1964	5
1956	13	1965	1
1957	2	1966	3
1958	2	1967	1
1959	7	1968	2

d. Potential solar radiation estimated by using measured slope and aspect to obtain radiation index from the tables of Frank and Lee (1966) for lat. 43° N.
e. Soil depth, texture, and series determined by digging pits in both clearcut and adjacent stands.
f. Temperature and moisture indices determined after identifying and listing plant indicator species present in the adjacent uncut stand. Minore's 1972 procedure was used (see appendix).

Additional general observations of stand conditions and plant species associated with stocked and unstocked clearcut areas were recorded throughout the study.

Stocking of conifer seedlings in each clearcut sample area was determined by running equally spaced parallel compass lines across the area. At least 20 circular 1/250-acre (1/620-hectare) plots were established at equal intervals along the lines. Spacing of these lines and plots (1/2 or 1 chain (10 or 20 meters)) varied with size of the clearcuts in order to sample adequately that part of each having the same slope, aspect, and soil series as the adjacent uncut stand. None of the plots were located on parts of the clearcut topographically or geologically dissimilar to the uncut stand. Tree seedlings were counted on each plot, and the plot was classified as stocked or unstocked. As old seedlings are more likely to survive than young ones, our stocking standards were weighted by seedling age. To be classified as stocked, a plot had to contain one of the following:[1/]

One tree at least 4 years old
Two trees at least 3 years old
Three trees at least 2 years old
Five trees at least 1 year old

Stocking percent for each clearcut sample area was determined by dividing the number of stocked plots by the total number of plots established on that area. For example, if 25 plots were established and only 5 of them were stocked, stocking would be 20 percent.

Quantitative data were grouped by soil depth and texture. Then stepwise multiple regression analyses were calculated to test the significance of relationships between the independent variables (elevation, moisture index, temperature index, radiation index[2/]) and the dependent variable (stocking percent). Relationships involving interactions between variables and squared variables also were tested.

RESULTS

Stocking ranged from 0 to 100 percent on the sampled clearcut areas--39 were at least 50-percent stocked; 18 had less than 50-percent stocking. The influence of environment upon stocking was readily apparent. One, harvested in 1954 and left for natural regeneration, was 86 percent stocked when sampled in 1972. Another, harvested in 1959, was only 9 percent stocked in 1972 after being planted three times, seeded, treated with atrazine, scarified by bulldozer, and planted again. Obviously, the environment was favorable for regeneration on the first and unfavorable on the second.

Regression equations indicated that elevation, radiation, moisture, and temperature were significantly related

[1/] These stocking standards were derived from those used in U. S. Department of Agriculture National Forest regeneration surveys. As our results are based on these standards, readers using different standards may find it necessary to compare stocking standards in the field before using the equations listed in the results section. General results should not differ with stocking standards, but small percentage differences probably will occur when different standards are used.

[2/] Slope and aspect are included in the radiation index.

to stocking percent on the sample areas:

Shallow soils

Stocking percent = 98.98 + 0.016 (elevation) - 227.48 (radiation index)

(R^2 = 0.522, standard error = 18.57)

Deep clay loams and clays

Stocking percent = -221.94 + 57.78 (moisture index) - 2.43 (moisture index)^2 - 8.57 (radiation index) (moisture index)

(R^2 = 0.621, standard error = 18.71)

Deep loams and sands

Stocking percent = 91.86 - 0.003 (elevation) (temperature index) -5.42 (radiation index) (temperature index) + 0.64 (temperature index)(moisture index)

(R^2 = 0.426, standard error = 22.06)

The above equations are only estimating aids, not precise prediction formulas. As the coefficient of determination (R^2) values indicate, these equations account for only about half of the variation involved in the observed stocking-environment relationships. Unmeasured variables such as seeding and planting methods, condition of the planting stock, soil temperature at time of planting, and weather conditions after planting account for the other half.[3/] Stepwise multiple regression standard error terms are difficult to interpret and apply, but those listed indicate that the equations are not precise. For example, the stocking obtained on a clearcut area with shallow soils probably will be within 18.6 percent of the calculated value only about two out of three times.

[3/] The regression variables are assumed to be measured without error.

Subjective examination and interpretation of our field notes and data indicated that poor stocking (less than 60-percent by the standards used) usually was associated with plant moisture indices below 9.0. Shallow soils and/or the presence of *Berberis aquifolium*, *Rhus diversiloba*, or *Lonicera hispidula* frequently were found where clearcuts were poorly stocked. Well-stocked clearcuts usually were associated with deep soils where the moisture index was above 9.0.

DISCUSSION AND CONCLUSIONS

Although the regression equations significantly relate measured environmental variables to observed stocking percentages, variation from the regression line may be substantial in predicting stocking levels in individual situations. The equations are recommended only as an adjunct to other information available to the land manager, to supplement his judgment based on experience in the local area. The equations also should be useful in comparing potential regeneration difficulty on areas to be harvested. Where the equations yield low stocking percentages, regeneration probably will be more difficult than where they yield high percentages.

The procedures described above and in the appendix constitute a first approximation to the difficult task of prescribing optimal harvest treatments for forested areas in the South Umpqua basin. We plan to continue research on this problem and hope to reduce variation and more accurately relate regeneration success to environmental conditions. In the meantime, we would appreciate receiving the ideas, comments, and observations of foresters using these procedures in the field.

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APPENDIX

VEGETATION TALLY SHEET

Vegetation tally sheet for determining South Umpqua temperature and moisture indices. To use, circle the values opposite each species[4/] present, total circled values in each column, and divide by the number of circles in that column.

Species	Temperature value	Moisture value
Abies magnifica var. *shastensis*	1	--
Actaea rubra	1	--
Adenocaulon bicolor	--	10
Amelanchier alnifolia	--	10
Anemone deltoidea	4	15
Arbutus menziesii	8	--
Arctostaphylos canescens	4	10
Arnica cordifolia	4	10
Berberis aquifolium	12	5
Berberis nervosa	--	10
Castanopsis chrysophylla	--	10
Ceanothus integerrimus	--	10
Clintonia uniflora	--	15
Corallorhiza maculata	--	10
Cornus nuttallii	4	10
Cynoglossum grande	8	--
Disporum hookeri	4	--
Festuca californica	8	5
Galium oreganum	1	--
Gaultheria shallon	12	10
Goodyera oblongifolia	4	--
Habenaria unalascensis	4	--
Ligusticum apiifolium	4	--
Lonicera hispidula	12	1
Montia sibirica	4	--
Osmorhiza chilensis	--	10
Pachystima myrsinites	4	--
Pinus ponderosa	4	5
Psoralea physodes	--	10
Pyrola picta	4	10
Quercus chrysolepis	8	--
Quercus kelloggii	8	--
Rhododendron macrophyllum	--	15
Rhus diversiloba	12	1
Rubus nivalis	--	15
Satureja douglasii	12	--
Smilacina stellata	--	15
Taxus brevifolia	4	--
Thuja plicata	4	15
Tiarella unifoliata	1	--
Tsuga heterophylla	4	15
Vaccinium parvifolium	--	10

[4/] Nomenclature follows Hitchcock et al. (1955-69) and Peck (1961).

Species	Temperature value	Moisture value
Valeriana sitchensis	1	--
Xerophyllum tenax	4	--
Total, circled values		
Number of species circled		
Average*		

*Average = $\frac{\text{Total, circled values}}{\text{Number of species circled}}$ = Index

Example: A stand with *Adenocaulon*, *Anemone*, *Arbutus*, *Arctostaphylos*, *Cornus*, *Goodyera*, *Lonicera*, *Rhus*, *Smilacina*, *Taxus*, *Vaccinium*, and *Xerophyllum* would have a plant temperature index of 6.2 and a plant moisture index of 9.0.